

April 12, 1991

SUBJECT: Status of ARS Screwworm Meetings, May 8-15

TO: All Participants

FROM: C.J. Whitten

The plans for the forthcoming meeting involving screwworm research activities are almost complete. Attached is a general schedule for the time period May 8-15 and the agenda for the Ecology Workshop to be held in Costa Rica on May 10. The agenda for the ARS-Methods Planning meeting has not yet been finalized, but will be sent to you at a later date.

I have tried to include telephone numbers for contact points at each location. The number for the ARS laboratory in Tuxtla Gutierrez is 011-52-961-33550, FAX - 011-52-961-30767. My home number is 011-52-961-36750. The best contact point for Costa Rica will be John Welch's home - 011-506-32-51-12 or the U.S. Embassy - 011-506-20-39-39.

All hotel reservations have been made. Arrangements have been made for you to be met at the arrival of your flights in Costa Rica and Tuxtla Gutierrez. With the possible exception of your flights to and from the U.S., we will be traveling in groups.

Please let me know if you have any questions or anticipate any problems.

GENERAL SCHEDULE FOR ARS MEETINGS, MAY 8-15

May 6 -8 Arrivals - San Jose, Costa Rica, Hotel Corobici
(Ph 011-506-32-81-22)

May 9 - a.m. Meeting of selected personnel with Deputy Chief of
Mission and Agricultural Attache at U.S. Embassy,
San Jose.

May 9 - p.m. Travel to Canas, Costa Rica, Hotel La Pacifica
(Ph. 011-506-69-00-50)

May 10 - ARS Mini-Workshop on Screwworm Ecology (Agenda
attached)

May 11 - a.m. Completion of workshop and tour of MAG experiment
station

May 11 - p.m. Return to San Jose, Hotel Corobici
(Ph. 011-506-32-81-22)

May 12 Flight from San Jose to Mexico City, Hotel Bristol
(Ph 011-525-208-1717) or Hotel Maria Cristina
(Ph 011-525-566-9688)

May 13 - a.m. Flight from Mexico City to Tuxtla Gutierrez, Hotel
Arecas (Ph 011-52-961-32467)

May 13 - p.m. Tour of Screwworm Production Plant

May 13 - nite Dinner at Palapa Balam

May 14 - ARS Planning meeting, ARS laboratory

May 14 - nite Dinner at Whitten's

May 15 - Annual ARS-Methods Development Planning Meeting,
Commission Meeting Room

May 15 - nite Dinner at the Ganadero

May 16 - 18 Transportation to airport

This item has been digitized as a selection from the Screwworm Eradication Collection.

Digital Item Number: 01380

Format: Meeting minutes

Additional Format:

Author:

Additional Authors:

Recipient:

Date: 15 May 1991

Minutes, Annual Research and Methods Development Meeting

Note:

Screwworm Eradication Records

Screwworm Eradication Collection

Special Collections, National Agricultural Library

SCREWWORM ERADICATION PROGRAM

MINUTES

ANNUAL RESEARCH AND METHODS DEVELOPMENT MEETING

Screwworm Production Plant
Chiapa de Corzo, Chiapas, Mexico
May 15, 1991

OPENING OF THE MEETING

The meeting was chaired by Dr. Ralph Bram, ARS National Program Leader, who began by thanking the Screwworm Commission for again sponsoring the annual meeting, which this year was a truly international event with scientists present from a number of countries throughout the world, in addition to Mexico and the United States. The success of the screwworm eradication program had been possible, first, because of the dedication of the program personnel, and secondly, because of continued research and methods development which provide a firm scientific foundation for its operations. These annual meetings were important in permitting an exchange of ideas and information and planning for future cooperative activities.

CURRENT STATUS OF THE ERADICATION PROGRAM

The first presentation, a report on the program in Mexico and Central America, was given by Dr. Steve Smith, Assistant Co-Director for Field Operations. In February Mexico was declared free of screwworms, the last case having been reported on July 10, 1990, and Guatemala and Belize are now considered an eradication zone. The case situation in that zone is favorable, with a steady decline of cases in Guatemala and Belize since last May. Positive cases detected have occurred mostly along the borders with Honduras and El Salvador and are probably due to migrations from uncontrolled areas in those countries.

Surveillance activities continue in Mexico, concentrated in the central part of the country where the majority of livestock movements from southeastern Mexico occur, and in Guatemala and Belize, where they are conducted jointly by field inspectors from the Ministries of Agriculture of those two countries and the Commission. Three permanent quarantine stations are in operation, as well as two temporary stations in the States of Quintana Roo and Campeche designed to keep the Yucatan Peninsula free of screwworms. No screwworms have been detected, but dermatobia samples were found in some animals which were quarantined to be sure there were no screwworm larvae in the same wounds.

Three dispersal centers are maintained in Mexico: in Ocozocuahtla, Tenosique, and Chetumal. Dispersals in the regular grids along the border are at a concentration of 2,000 flies per square mile to provide a sterile-fly barrier against any migration of flies from Guatemala. Flies are now being dispersed in Guatemala from centers located in Retalhuleu and Puerto Barrios, with all of Guatemala covered since January with the exception of some mountainous areas not considered susceptible to screwworm infestation. Releases in the grids in Guatemala are at concentrations of about 3,500 flies per square mile, reduced to 2,500 in a few areas. Special treatment with concentrations of 4,000 to 4,500 flies per square mile has been given in two grids in Guatemala, one in Belize and one in Mexico along the border with Belize to combat persistent infestations. Current dispersals are at the rate of about 140 million flies per week, up from an average of 115 million at the beginning of the year. Of a total of about 6 billion flies dispersed since last May, 15% were released in Belize, 55% in Guatemala, and 30% in Mexico.

Future activities will involve expansion of the program in Central America. Negotiations are under way with the governments of Honduras and El Salvador to initiate an eradication program in those countries sometime in the middle of this year with chilled sterile flies dispersed in western Honduras and all of El Salvador. Since last May fly dispersals in Mexico have been gradually reduced as they have increased in Guatemala and Belize, and it is expected that by the end of this year there will be no flies released in Mexico.

In free zones in Mexico there has been a dramatic decrease in submission of negative samples, which would seem to indicate that livestockmen are no longer checking their animals carefully and there is a problem of maintaining an awareness of screwworms as the impact of the program is reduced.

Next, Dr. Carlos Bajatta, the Commission's Assistant General Director, reported on the operation in Libya. Screwworm infestation was diagnosed in the vicinity of Tripoli in 1988, causing alarm because of the risk that it might spread to other countries in Africa. At the request of the Libyan Government and FAO, the Screwworm Commission joined a cooperative eradication effort, providing laboratory work to determine that the strain produced in Mexico is compatible with the Libyan strain, consulting by Commission personnel who travelled to Libya, training of Libyan personnel in Mexico in all of the program's activities, and material and equipment with which to implement the program.

In December 1990, after amendment of the international agreement which is the Commission's operating authority, an agreement was signed between the Commission and FAO, under which shipments of sterile flies with which to conduct the campaign were initiated. The first shipments were at the rate of 3.5 million flies per week, increasing to 7 million and then 28 million, all of which were trucked to Mexico City and then flown to Tripoli. Beginning May 3, 40 million flies per week will be flown directly to Tripoli from the Tuxtla Gutiérrez airport. If needed, this amount could be increased to 100 million by October. If this larger number is required, production at the plant can easily be rescheduled so that the program in Central America will not be affected.

Favorable results have already been obtained, with positive cases dropping from a high of 4,000 a month at the end of 1990 to none in March 1991 and one in April. It is hoped that eradication can be achieved within a short time. Quarantine measures have been adopted to prevent the spread of the pest, particularly in countries such as Tunisia where there are heavy livestock movements. To date, no cases have been reported outside of Libya. Since the pest exists only in the Americas, its entry into Africa must have been by means of an animal shipment from this hemisphere, but nothing further is known on this point.

STATUS OF THE OW-87 STRAIN

Dr. James Mackley, chief of production at the plant, reported on the various parameters which give a picture of the status of the current strain, starting with larval weight, which now averages between 42 and 43 mgs., down from the traditional 45 mgs. It is believed that this drop may be due to a problem of increased density on the rearing trays, since yields of pupae per tray are up, and Methods Development has been asked to look into this. Yields, using the same infesting rate of 1.25 grams of eggs per tray, have gone up from an average of 1.59 liters to 1.68 liters, a substantial increase, representing an efficiency of 60%. The number of pupae per liter has increased by 2 to 3%, which is a reflection of the drop in pupal weight. The average weight of immature larvae at 56 hours of age is now 16 mgs., which compares with 11 or 12 mgs. when rearing with hydroponics. Therefore, gel-reared larvae are 40 to 50% heavier at this stage, which is a good indicator of the health of the strain.

For the colony, egg harvests are an important parameter, which is currently an average of 34 to 35 grams per liter of broodstock. This figure fluctuates, mainly as a function of the colony's environment, that is, temperature and relative humidity. This is quite good, as can be seen by comparing with the level of 10 to 13 grams which is usual for a new strain.

Liters of diet per tray, a parameter measuring efficiency of diet utilization, remained fairly constant, although the feeding methods do not permit precise measurements. Nevertheless, a 2% decrease in the amount of diet used was achieved during the past year.

The last parameter referred to the percentage of eclosion, which was 92.6 for the year just ended, as compared with a figure in the high 80's with the hydroponic system, another indication of higher yields from the rearing trays.

Dr. Luis Hernández, Assistant Director for Production, added that because of the change from hydroponics to the gel diet, a true evaluation of the status of the OW-87 strain could not be made until there were two periods on similar diets which could be compared.

Biologist Irene López González, head of the insect quality unit, reported that it could be concluded from the various insect quality control determinations made after irradiation, including 72-hour emergence, flight incapacity, longevity, resistance to starvation, pupal weight, sexual aggressiveness, sex ratio, and mortality, that the strain was tending to become more homogeneous following the change from hydroponics to the gel diet.

DEVELOPMENT OF THE COSTA RICA-91 STRAIN

Dr. James Whitten, ARS research leader in Tuxtla Gutiérrez, reported on development of a new strain, to be known as Costa Rica-91, which had begun in January. Two new concepts were involved, one being that it had been obtained from egg masses collected at a liver site, instead of from a wounded animal. The other was the formation of a pre-strain strain, which provided a ^{NON} less laboratory-adapted line for early use, if desired. The pre-strain is a mixture derived from pupae from the 16 different lines involved in the development of the CR-91 strain, combining them and allowing them to mate by choice, thus forming the pre-strain strain. After full development of the new strain, it would be compared with the pre-strain, and if there are no important differences this method could be used for fast strain development, if necessary. The principal parameters employed in deciding which lines would be used in developing the new strain were oviposition, size, and yield. The free-choice method of crossing was used. Generational development was proceeding on schedule, and it was expected that the first pupae would be ready to be turned over to Methods Development at the end of July or in early August. from flies

In response to a question, Dr. Whitten said that 66 egg masses had been collected originally, half of which had oviposited. ^{OR SURVIVED} Methods Development indicated that in future years the concept of a pre-strain could be very useful.

LARVAL DIET FORTIFIERS/A.A.

Dr. Dan Friese, ARS research entomologist in Tuxtla Gutiérrez, reported on a study being made of the effects of adding amino acids to the larval diet, following the work done by Gingrich to develop the original screwworm diet. The purpose was to determine whether the addition of amino acids in a purified state would improve some of the parameters used to gauge screwworm development and performance, which were pupal weight, emergence, percentage of males, percentage of eclosion of females developed from larvae reared on the diet, fecundity, and total volume of pupae produced. The amino acids tested were glycine and arginine. The test diet was the normal screwworm diet, to which each of the amino acids was added in different concentrations. eggs oviposited by

The conclusions were that when the higher concentrations (^{2.75 grams per liter} ~~10 grams per liter~~) of both glycine and arginine were added to the diet, the total volume of pupae produced, mean pupal weight, and percentage of males were all affected adversely. In addition, at high concentrations of glycine, an effect on the percentage of emergence of the adults and on egg eclosion was seen. These findings support the idea that there is a toxic effect from these amino acids at high concentrations. In this study the concentrations already in the diet were not considered; further analysis showed that these levels were sufficiently high that by adding more of the particular amino acid, concentrations were obtained that were tenfold those listed by Gingrich. The next step will be to return to the lower ranges to see where the responses might be. It would appear that with the present diet, there is no response to these two amino acids that could be utilized to improve production. (5.0 & 10.0 grams per liter)

GELLED MERIDIC ADULT AND LARVAL DIETS

Continuing with the topic of diet research, Dr. Douglas Brewer, ARS research entomologist in Tuxtla Gutiérrez, reported on a study conducted to see if the honey water diet for adults could be replaced with an artificial diet, called a meridic diet, that has been gelled. This was based on a preliminary study done here in 1988 by Dr. Taylor which indicated that female adults feeding on a diet of two parts of sugar and one part of whole chicken egg which was gelled with .45% carrageenin, laid more eggs than those fed on a honey diet.

In the study, Taylor's test diet was compared with the honey diet, with confirmation of his finding as to increased fecundity, and then compared with two other carrageenin gel diets, one formulated by adding one part of non-fat powdered milk to the sugar-egg diet and the other with one part of spray-dried whole bovine blood also added. Differences noted were that adult males receiving the diet containing blood were significantly smaller than those on the other diets, females fed the sugar-egg diet were heavier than those on the other formulations, and fecundity was highest for females receiving the sugar-egg-milk diet. This finding also applied to a repeat of the test done with flies from the CR-91 strain.

In the next experiment the carrageenin in the sugar-egg-milk formulation was replaced with Water Lock G 400, a synthetic co-polymer which does not require heating before mixing the diet. There were no significant differences in adults fed this diet. Lastly, the Water Lock formulation was modified by using a super-absorbent material trade-marked as Grit o'Cobs as a partial replacement for the Water Lock in various concentrations and percentages, with no significant differences observed in the parameters except for fecundity, which varied from one diet to another but not uniformly. Further study is necessary to determine how much Water Lock substitution can be made, which would result in a diet cost saving since Grit o' Cobs is less expensive than Water Lock.

Gelled meridic diets offer many advantages over the honey diet, such as over-all performance, nutrition, cost, storage, handling, logistics of ordering, and consolidation of ingredients. Honey is not used in rearing larvae, whereas the dried powdered ingredients comprise part of the larval diet and are therefore already on hand. It was estimated that the cost of the gelled meridic diet would be about half the cost of the honey diet.

Biochemist Luis Alberto Alvarez, chief of the methods development unit, reported on a study of gelling agents for the larval diet, seeking lower-cost substitutes for Water Lock gel. The agents tested were 630-1, 630-2, and 630-3. The test objectives were to determine the right concentration and consistency of the gels and to compare the usual parameters, including larval weight, yields, pupal weight, pupation, pupal weight, and emergence. It was found that a 2% concentration gave the best consistency. The statistical analysis showed parameters that were substantially lower for all three experimental gels than for Water Lock, from which it is concluded that they cannot be considered as substitutes.

NEOMYCIN IN THE LARVAL DIET

Biochemist Roque Jonapá, from the methods research unit, explained that due to bacterial

contamination of the larval rearing vats it was necessary to apply a bactericidal agent, with formaldehyde currently used for this purpose, at .1%. It has been proposed that it be replaced by neomycin, a broad-spectrum antibiotic, and therefore a laboratory evaluation of its effectiveness as an antibacterial agent in the flora of screwworm cultures was conducted. The results obtained were that the level of inhibition of bacterial growth obtained in the *in vitro* study was sufficient to continue with *in vivo* tests.

The *in vivo* tests were reported by Mr. Alfredo Villalobos. Substituting neomycin for formaldehyde would reduce production costs, improve quality, and eliminate the risks involved in handling formaldehyde. The objectives of this test were to determine the bactericidal effect of neomycin in the screwworm biological cycle and evaluate its effect in the larval diet. It was to be done in three replicates, of which the first had been completed. Of the various concentrations tested, 2.4 mgs. was the most successful, and compared favorably with the control which was the current treatment of .1% formaldehyde. Larval and pupal weights were slightly lower, but this was a reflection of increased yields. No adverse effects on larval development were detected, leading to the conclusion that it would be feasible to substitute neomycin at a concentration of 2.4 mgs. for formaldehyde, resulting in a cost reduction. The trial would continue in order to confirm these results.

In response to questions, it was reported that the predominant bacteria found were the group of enterobacteria, and also that there was no ill effect on fecundity. It was also commented that bacterial contamination is inherent in the process, from environmental causes and because of the dietary system used. Neomycin was chosen over other antibiotics because of its broad spectrum and lower cost.

STATUS OF SCREWORM ATTRACTANTS RESEARCH

Dr. James Whitten stated that research on attractants would no longer be done in Fargo, North Dakota, and all the funds allocated to this activity would be expended on research done in Mexico and Costa Rica, with less emphasis on chemistry and more on field ecology, such as plant influences and wound ecology.

SCREWORM TRAP DESIGN AND ATTRACTANT DEPLOYMENT

Dr. David Hall, an expert chemist from the Natural Resources Institute in Chatham, England, reported on research being done on screwworm flies, following studies they had been doing in Africa with the tsetse fly. These flies are attracted to animals by both smell and visual stimuli. A lure has been developed which is a stronger attractant than live animals. With insecticide placed on baited targets, the killing effect is achieved by merely having the flies strike the target. This is different from the SWASS approach, in which the insect has to feed if it is to be killed. When screwworms appeared in Libya, it was thought that surveillance and control methods should be developed that would be applicable to the African situation, and these simple traps and targets are such techniques.

A series of experiments was run in Mexico to determine, first, the visual response of

screwworm flies in the field applying techniques used in tsetse fly research, with electrified nets as catching devices. The first experiment was to see whether colored targets influenced screwworm flies to come to a swormlure-baited trap, with no such effect observed. The second set of experiments was designed to determine the number of flies that would land on a colored target, also using swormlure. Here, a strong response was obtained when a black target was used, though not with a white, blue, or yellow target, with male flies landing on the black target at a rate of seven times more than on a wind-oriented trap and females two to three times.

The next studies, conducted in England with flies sent from Mexico, were to determine the susceptibility of screwworm flies to the insecticide, which was Deltamethrin. Three methods of application were analyzed: one, the standard topical application, secondly by bouncing the flies off an impregnated net to simulate their striking a target in the field, and thirdly, exposing the flies to a cloth impregnated with the insecticide for a longer time. The flies proved to be much less susceptible to Deltamethrin than the tsetse fly and the first two methods gave poor kill rates, but with the third method, and impregnating the cloth target with much higher concentrations of the insecticide than the .2% used for tsetse flies, almost 100% kill rates were achieved with 10 seconds of exposure. Therefore, this control method could be used for screwworms with some modifications, taking advantage of the high landing rate. There is also a knock-down effect, that is, the surviving flies are sufficiently weakened for the next 24 hours to be easy prey to predators in the field.

Some work had also been done on swormlure dispensers, using on sealed polythene sachets developed for tsetse control, with the attractant diffusing out through the polythene. The advantages are that this provides a sealed system, and the release rate is controlled by the surface area and thickness of the polythene sachet, permitting the design of dispensers for specific release rates. The release rate is independent of the amount of attractant in the sachet, giving a linear release throughout its lifetime. In trials with the individual swormlure components, it was determined that each could be released by polythene sachets, and the limiting factor for their design would be the rapid rate of release of dimethyl disulfide, which would require a thick-walled sachet. They hope to test a double design, with one sachet for this component and a thinner-walled sachet for the other components.

They then considered natural screwworm attractants. In the tsetse work, they have identified the main components of wound odor that form the remote attraction, using a technique known as electroantennography. Since insects detect odors with their antennae, by placing microelectrodes in the antennae it can be determined what active compounds cause a response from the insect. The electroantennogram (EAG) is coupled to a gas chromatograph, with which to separate the components of an odor mixture. The EAG at the outlet of the gas chromatograph allows the insect to give an indication of the biological activity of the components as they emerge from the GC. So far, the work has involved determining whether EAG recordings can be made from screwworm flies and screening some of the components of swormlure and the chemicals used as tsetse attractants.

The results obtained so far are in the form of the dose responses of screwworms to these

components in comparison with a standard compound. The best response is to valeric acid, equal to the standard. There is no significant difference between males and females. Another good response was to 1-octane-3-ol, an attractant for the tsetse fly and several species of mosquitoes, which had been tried unsuccessfully in Mexico in the field at a low dosage, and which in view of the electroantennographic response should be studied further.

Going on from here, they will be studying the response to natural odors, using the electroantennogram technique. For this, a behavioral bioassay is needed and is being developed in Bristol in the form of a simple wind tunnel with a video camera to record the behavior. There is an odor source and targets on both sides of the tunnel. The flies are placed in the tunnel, with a period of no odor, a period of exposure to an odor, and then a period with none. The effect of the odor has been observed in the form of more flight by the insects and less repose during the odor exposure. An even more marked effect is that of actual collisions with the target, using a red and a yellow target. With no odor, there was very little contact with the target, but during the odor exposure there were enormous numbers of collisions of the flies with the target, with a marked preference for the red target over the yellow. Targets of other colors were tested, and there was a similar increase of landings on a black target. This bioassay technique should be very useful in behavior studies.

In response to a question, Dr. Hall stated that swormlure as a whole had not been studied, but although it is known that swormlure greatly loses its effectiveness if even one of its ten components is absent, the electroantennographic response should be the same for each individual compound, whether other compounds are present or not. One thing to be established in the studies in Mexico is the nature of the odors mimicked by swormlure, whether they are carrion, fecal, nectar, or other odors.

PERSISTENCE OF STERILE FLIES AT RELEASE SITES

Dr. Don Thomas, ARS research entomologist in Tuxtla Gutiérrez, reported on a study of the fly characteristic that could be called "persistence", referring to the time they remain on the site after release before either migrating elsewhere or dying. Sites for the recapture of marked flies were set up, using sentinel sheep to attract OW-87 females transported by truck from the plant to the sites in Belize where they were released, with 4,000 females released in each replicate.

Earlier studies using swormlure indicated that flies were found in the area for only three to five days following their release. With the sentinel animals, there was an increase in the number of flies after reaching the age of reproductive maturity, that is, even though they were sterile, they were still attracted to animal wounds at the time they would be ovipositing if they were fertile. Persistence remained high until nine or ten days, with small numbers of the marked flies found as long as 18 days after release. The study was done in six replicates in the spring of 1987 and six more in the fall of the following year. Big variations in the recapture rate from one replicate to another were found both in the spring and in the fall which were not weather-related; that is, there were good and bad recaptures in both hot, dry weather and in cool, rainy weather. It was found that the recaptures for the first

replicate in both seasons were the worst, so it might be that the insects suffered more stress in the first shipments both times. The sheep were positioned two weeks prior to starting the releases in order to create the effect of a build up of attraction which is known to occur. In comparing the life span of the sterile flies with that of wild flies, it was found that the longevity of the factory-reared flies compares very well with the expected longevity of wild flies.

METHODS DEVELOPMENT IN GUATEMALA

Dr. Jorge Alfredo Calderón, chief of methods development in Guatemala, gave a brief review of the status of the program in Guatemala, complementing what had already been described by Dr. Smith. He showed maps indicating that in recent months the highest concentration of cases has been along the borders with Honduras and El Salvador, where sterile flies have been released since December of last year.

Some problems were occurring during shipment of flies from the packing center in Ocozocuautla to the dispersion centers in Guatemala, which under normal conditions takes from 38 to 40 hours in the case of Puerto Barrios and from 23 to 25 hours to Retalhuleu, including delays en route due to mechanical breakdowns of vehicles, variations in temperature inside the trailers, racks in poor condition, delays in customs clearance at the border, and too much moisture in the boxes which causes handling problems when loading them into the planes. The delays in arrival meant that there was only a limited time in which to disperse the flies in order to do so within the 72-hour period set for their release, as well as increased mortality rates and flight incapacity due to stress. Shipping delays also result in payment of overtime, which increases operational costs. His recommendations were that the ThermoKings be improved to avoid delays in transit and provide optimum shipping conditions inside the trailers, and that the dispersion centers be supplied with telethermometers and other similar devices.

In reply to a question, Dr. Calderón stated that in spite of these problems, the flies were giving good results, as shown by quality control tests in the field. The exceptions were two shipments, in one of which there had been 100% fly mortality and 50% in the other.

NAKED PUPATION

This presentation was made by microbiologist Eric Babilonia. Under the current pupation process, larvae are placed in sawdust in ABS plastic trays for 16 hours and are then taken to the sawdust-pupa separator which by vibration sends the sawdust out one side and the pupae and unpuated larvae onto a conveyor belt where they are separated by phototropism, with the unpuated larvae falling into holding trays. To increase efficiency, studies are being made of naked pupation with the objectives, first, of inducing pupation without the use of sawdust; secondly, to determine the effect on the percentage of pupation, pupal weight, and percentage of emergence; and thirdly, to do a brief analysis comparing the economics of naked pupation versus pupation in a sawdust medium. A modified tray was used, placing a stainless steel mesh on the bottom, which was sealed to prevent larval escape.

The results obtained showed a slight decrease in all three parameters with the naked pupation system, in comparison with the use of sawdust, which was statistically significant. The difference was 1.36% for pupation and 1.48% for emergence. However, the economic analysis gave a saving of 35% with the use of naked pupation, considering the cost of sawdust and the costs associated with the separation process, such as electricity, maintenance and parts for the vibrator, and increased manpower requirements. The slight reduction in the number of insects reared amounts to about 20,000 flies per million, which could be compensated for with 1.5 additional trays of larvae per million. Further trials will include changes in the illumination, using either complete darkness or infrared light which would not be visible to the pupae, to induce earlier pupation. Temperature and relative humidity should also be closely controlled. In the first trial, the control group was treated with greater care than occurs under normal operations. It is believed that with further refinements, the naked pupation system could improve the efficiency of the rearing operation.

A question was asked as to how the absence of a pupation medium would affect the concentration of ammonia in the atmosphere. The reply was that the sawdust medium becomes impregnated with residues of the diet during the period it is used, which with the degradation of the metabolic wastes brought in from the rearing trays results in an increase in the bacterial population. This affects the quality of the insects. In naked pupation there is no medium to become impregnated with residues, and in addition, the trays are washed between rearing cycles, which is not the case with the sawdust-based system. Therefore, there would be a decrease in the ammonia concentration. Another question had to do with the illumination during the test. The answer was that it was done under the normal illumination now in effect in the pupation area, which has been shown to delay pupation. Regarding the mesh in the bottom of the tray, he stated that this provides ventilation to reduce the moisture on the trays, as the drying out process also delays the onset of pupation, whereas in the other system the sawdust absorbs the moisture. A comment was made by a participant to the effect that in naked pupation tests done in Mission, insect size and quality had been reduced; it was felt that 2 mgs. per pupa was a substantial loss.

DOSIMETRY

Mr. Eliud Cantú, supervisor of the radiation and packaging unit, explained that ensuring that the irradiators are functioning properly to ensure insect sterility is a vital part of the rearing process. At present the Fricke dosimetry test is being used, but a trial had recently been made with a possible alternative known as GAF chromic dosimetry medium. This is a radiation-sensitive film which is colorless, transparent, and with no granulation before exposure to radiation. When exposed, it turns dark blue in color, and the greater the exposure the darker blue it becomes. The materials are of a low atomic number so that the film will not affect the radiation fields for most products. It is insensitive to ambient light, which facilitates handling and storage. The dosage is evaluated by measuring optic intensity in each of the irradiators with spectrophotometry and then calculating the dose absorbed in millirads by using a table. This spectrophotometric analysis showed the accuracy of the test material. Dosimetry testing using this system could be performed at a cost of only \$108, representing an enormous saving in comparison with the Fricke test. Mr. Cantú added that

the material for dosimetry can also be used to test new prototypes of equipment, such as cylinders, thus avoiding long delays in putting the equipment into use.

A comparison of the data obtained from each irradiator showed that there were differences in dosage from one unit to another. It had been thought that unit No. 4, acquired five years after the other three, had a lower capacity, but this test indicated that this was not the case. Because of that assumed lower capacity, a longer exposure time was being given with unit No. 4, resulting in a higher dose. It was felt that all the units should be adjusted and the dosage reduced from the present 8,000 millirads to the maximum required for females of 6,000 millirads. An excessive dose could effect the longevity of the insect.

In response to a question, it was stated that the Fricke test had been used three times since the irradiators were installed, which was insufficient. With the GAF system, testing could be done at least once a year. The Fricke test can be performed only by a specially-trained person, whereas the GAF test can be done by any worker in the radiation unit. Dr. Ashley explained that the sensitivity of this test gives early warning of the need to adjust the irradiators, before any biological effect has occurred.

A comment was made that last year there had been considerable discussion about irradiated females having mature ovaries, and the question was asked whether this had been considered in the proposal to reduce the dosage since finding egg masses, even though they were not fertile, was a disruption to surveillance. Mr. Babilonia replied that in spite of considerable research done on this eugenic development in sterile flies, it had not been possible to pinpoint the cause. The phenomenon comes and goes, regardless of the radiation dosage.

REFRIGERATED PUPA

Biologist Reynaldo Moctezuma, assistant head of the Department of Research and Experimental Development, described a trial conducted in the insect quality control unit to determine whether the quality of the insects would be affected when pupae are stored at a low temperature for varying periods of time. The trial took place from February to April 1991, with chilling at a temperature of 10°C. for periods of from 0 to 120 hours of storage, and time and period of emergence and flight capacity taken as the evaluation parameters. The results indicated that the damage suffered by the pupae was directly proportional to the duration of the chilled storage, with emergence decreasing from 93.5% for the control at 0 hours to 87.5% for the test at 120 hours, and flight incapacity reaching 7% at 72 hours.

In reply to a question, it was stated that malformations were found in adults, mostly in the form of unfurled wings. Another query was about the maximum period of chilling to be recommended, and on this the conclusion was that on the basis of total emergence, with 90% as the acceptable minimum, exposure to chilling could be for as long as 96 hours. However, based on flight incapacity, the allowable period would be only 48 hours when it was found to be 5.5%.

REACTION OF OW-87 PUPAE AND ADULTS TO CHILLING

María Larrinaga, head of the special tests unit, reported that a field test was being conducted to determine the behavior of OW-87 pupae and adults when submitted to low temperatures for prolonged periods of time. The first part of the test involved pupae chilled at the plant for 2 hours and for 48 hours following irradiation. These were divided into five groups, with the first chilled for a further 24 hours and then held at 26°C and the time of emergence was recorded. The other groups were kept at 10°C for 48, 72, 96, and 120 hours and then the time of emergence was recorded. There were also five control groups with 0 hours of chilling, which were kept at 26°C for 24, 48, 72, 96, and 120 hours, and emergence was recorded, being highest at 48 hours.

The next phase of the test was with adults, which were kept at 26°C, also divided into five groups. Emergence was determined, and 48 hours later they were all placed at 10°C, and kept respectively for 24, 48, 72, 96, and 120 hours, with control groups kept for the same periods of time at 26°C. The pupae were transported to the field under refrigeration.

The conclusions reached were that the quality of the insects deteriorates if they are kept for long periods of time at 10°C. When this occurs in the pupal phase, emergence decreases, and flight incapacity, malformations, and mortality increase. The deterioration is in proportion to the length of time they are kept chilled. In the adult phase, when the insect is subjected to low temperatures beginning 48 hours after emergence, mortality rises but flight incapacity and malformations fall within the same ranges as for conventional handling. These are preliminary results, since the study is ongoing.

A question was asked as to whether there is any difference between the pupal and the adult phases. The reply was that the deterioration is more marked when chilling occurs in the pupal phase than in adults, since the low temperature causes metabolic repression in pupae which still require primary metabolic products for their development, whereas in adults it is only a question of energy.

LONG DISTANCE SHIPMENT OF PUPAE

Dr. James Whitten reported on some small shipments of insects made last year to Vienna under conditions of anoxia. They were packed in sealed plastic bags, following 24 hours in the cold room at the plant. Thereafter, for the period of approximately 48 hours required to reach their destination, they were at room temperature. However, there was the possibility that some areas of the aircraft may have been at temperatures of close to 0°C. Samples were taken prior to shipment and retained at the plant as controls. The over-all results indicated that the parameters on arrival for the insects shipped in an anoxic condition were reasonably good.

Mr. Dirk Reich, from German Cargo Services, was asked to comment on the conditions for shipping insects to Libya. The flies are being shipped boxed, in wire baskets. The first shipments via Mexico City and Frankfurt were made at 10°C for the entire journey. This was then changed so as to raise them to 20°C in Bermuda for the rest of the trip. Libya is

now requesting that the temperature be raised to 24°C before departure from the plant so that releases can begin soon after arrival. One problem is that the sides of the aircraft are well insulated but not the floor, which sometimes is close to 0°C. Precautions are now being taken to place six layers of wood under the pallets to raise them above the cold air. These conditions are still in a testing phase.

Apparently all the shipments made so far, both via Mexico City and the two made directly from Tuxtla Gutiérrez, have arrived with no major problems. Careful temperature readings will be made in the next shipments and quality control findings will be reported. Another potential problem could be high temperatures resulting in emergence during the journey, with the possibility of free-flying insects on board.

CHILLED FLY PROGRAM IN BELIZE

Dr. Don Bailey, entomological adviser to the Director, began by explaining that the chilled-fly method makes it possible to release the flies directly into the air through a chute in the bottom of the aircraft, instead of packing them in boxes. A test had been set up in southern Belize to determine the feasibility of using this method. This was not a new concept, as it had been used in southwestern United States to avoid dropping boxes over cities.

The emergence and chill center was set up in three trailers previously used to transport boxed flies, which were placed side by side, with the chilling unit in the middle and slots cut in the walls. The two emergence trailers were painted black inside and the chilled trailer white. After the pupae were loaded into the emergence units, all illumination was eliminated, with sodium vapor lights in the chilled trailer. After the adult flies emerged and dried their wings, they were attracted by the light into the chilled unit, where they were held until the boxes were loaded into the aircraft. The system had been tested at the plant before being moved to Puerto Barrios, and it had been found necessary to add an additional refrigeration unit in order to be able to alternate the defrosting cycles and keep the flies constantly chilled. The units were also roofed over, to protect them from sunlight.

The trial in Belize lasted from March 1990 to March 1991, with a little over half-a-billion pupae shipped to Puerto Barrios. The average emergence was 90.3%, or 498 million flies, of which 453 million adults were collected after flying through the slots into the cold room. One advantage of the system is that all insects dispersed have already flown once, proving that they have the energy to fly through the slot to be collected. The results from the year's trial were that 82.1% of the pupae were harvested. Of the adults that emerged, 90.9% were collected, that is, about 9% of the emerged flies did not fly through for various reasons, such as lack of energy, malformations, or failure to find the slot, but this was a good yield.

The number of cases of screwworms detected in livestock in southern Belize has dropped off markedly since fly dispersion began in that area in March 1990, from a peak of 49 in December 1989 to 2 in December 1990, and no cases in southern Belize in the last two months.

A new chilled-fly facility has been designed to replace the prototype, and will have a production capacity of 30 million, compared with 10 million for the test unit. The plan is to install one such facility in El Salvador and four in Honduras to cover those two countries, giving a total capacity of about 150 million flies per week, or perhaps more. The units will be mobile, so as to be used throughout Central America.

In response to a question, Dr. Bailey stated that during the initial six months of the test, flies were released at a rate of 2,400 per square mile, which was later increased to 3,000.

STATUS OF SCREWORM GENETICS RESEARCH

Dr. David Taylor, ARS resident entomologist in Fargo, North Dakota, previously stationed in Tuxtla Gutiérrez, reported on new work being done with isozyme electrophoresis as a technique for looking at genetic differences among insects or populations. It is based on the fact that proteins are chains of amino acids, five of which have charged side chains, some positive and some negative. Substituting a charged for a neutral amino acid in a protein changes the charge of the proteins, making them move at different rates in electrical fields. Therefore, a change in the DNA which is the coding for these proteins can result in proteins which migrate at different rates and can be detected by using histochemical staining techniques, permitting the identification of individuals that are homozygous for a slow-migrating or a fast-migrating allele and others that are heterozygous, with one gene for the slow and one for the fast. By looking at the relative frequencies of these alleles, the relatedness and different characteristics of populations can be determined. Applications of the electrophoresis technique to the screwworm program would be in quality control, basic genetics, studies of population structure, and systematics, or the relatedness of the different species.

For quality control, a native screwworm population can be examined, in which variability would be seen at a given enzyme locus, with some individuals with a slow allele, some with a fast, and some heterozygous. If a colony was examined, a change in gene frequency would be seen, with a higher frequency of the fast allele, and much less variability. This implies that the colony has become inbred and has lost genetic variability, which means that colonization has changed the strain and the changes should be studied. This would not give a direct evaluation of quality, but would be an indicator.

In basic genetics, the enzymes can be used as genetic markers in establishing the screwworm genetic linkage map for doing studies such as genetic sexing and other basic genetic studies.

Population structure studies are important because the eradication program assumes that the screwworm in mass production will mate randomly with the native flies, that is, it is panmictic. A panmictic population is one in which there is random mating with both homozygotes and heterozygotes for the different individuals. If, on the other hand, all the individuals are seen to be homozygous for different alleles, this implies that there are two different populations, in other words, there is no inter-mating, resulting in population substructuring, an indication of sibling species and the sterile strain could not control both of them. Electrophoresis can be used to look at native populations to see if there is

population substructuring, which would be an indication that there may be problems in the future.

It can also be used if the program encounters problems as it advances into new areas where the populations are resisting control. By using electrophoresis these populations could be examined to determine whether they are similar to populations that have been controlled previously with the strain in mass production or are genetically different. There are two possibilities when problems of control are encountered: one would be technical, with failure to deliver high quality flies, and the other the possibility of having random, non-mating populations, and this could be detected with this technique.

Another use for the electrophoretic technique is to see the amount of variability that exists in screwworms. It has been thought that the screwworm is genetically very homogenous, but as yet there are insufficient data with which to verify this. Work will begin on this at the end of the year, and if confirmed, the next point would be to determine whether this is a characteristic of screwworms only or of the whole genus *Cochliomyia*. Is the screwworm a native species in North America? It is known to be in South America, but there is no reference to screwworms in North America prior to the 19th century, so it is possible that it was introduced into Central America by livestock movements. The importance of this lies in the fact that screwworms were controlled with relative ease with the sterile-insect technique, whereas it has failed in attempts against most other insects. The success with screwworms might be due to its being an introduced species with low variability. These things could be studied with this technique, and perhaps research could be done to determine what other species might be susceptible to the sterile-male technique.

Another field that could be studied with isozyme electrophoresis is systematics, or how species are related, such as how close is the relationship between *Cochliomyia hominivorax* and *Cochliomyia macelaria*, although the preliminary data indicate that these two species are very distinct.

Basically, what has been done is to develop this electrophoretic system. There are now 21 enzyme systems than can be studied, an increase from six or seven when the emphasis on this program began, representing 31 loci. Of these, 12 have so far been determined to have variability and can be used for population genetic studies, and it has been possible so far to map the position on the chromosomes of four.

Changing to another topic, he said that they were continuing their work on genetic sexing mechanisms. The concern has been about recombinant individuals, as they are getting recombination between sex and mutants that are being used as conditional lethal models. These could represent the deterioration of a genetic sexing strain. What has been determined to date is that these individuals are not true recombinants, but are retaining the translocation constructs as they are put together and do not represent a problem with regard to the stability of the genetic sexing strains. This work should be completed within about a year, after which they will begin working on the conditional lethal systems.

A question was asked about what would happen regarding strain changes, which in the history of the program have been made every one to five years, once a sexing strain has been developed and become laboratory-adapted. Would another sexing strain have to be made? Dr. Taylor replied that either they would have to make two crosses to cross the new strain material into the genetic sexing mechanism or make a new one. He said, however, that once the problems in making the sexing strain have been overcome to make the first one, making new sexing strains would not be difficult.

There was also a question as to why more electrophoretic work had not been done on screwworms in the past, with the reply that it required more manpower than had been devoted to it previously, and also that until now the technique had been applied with starch gel electrophoresis and the recent work was with polyacrylamide gel electrophoresis, which opened up several enzyme systems that had not worked previously. Dr. Taylor expressed the opinion that few differences will be found between the present location and Panama, but that a great deal of variability will be encountered once the program moves into South America, and research should be directed towards future advances.

SCREWWORM ECOLOGY IN CENTRAL AMERICA

RESEARCH

Dr. Frank Parker, ARS ~~regional~~ entomologist in Costa Rica, reported on studies of natural attractants conducted with marked flies in the dry tropical forests on the Pacific coast and the wet tropical forests on the Atlantic coast of Costa Rica, using sentinel sheep and liver as attractants. The screwworm adult is primarily a forest-dwelling species, with few flies found in the pasture areas. It was found that on the edges of the woods and inside the forest more flies were attracted to liver than to sheep but there was no difference in the pastures. There was also a seasonal effect between the wet and dry seasons in the degree of attraction of liver, but not of sheep. The important result obtained from the study is that sheep and liver are very different in their level of attraction and sheep data are very biased in estimating population densities.

movements

Fly exchanges were analyzed, and it was found that ~~none~~ ^{few} of the flies marked in the woods ventured out into the pastures and ~~none~~ ^{few} of those marked in the pastures went into the woods. The net movement was within the woods and not out into the pastures. Half of the marked flies never left the area of the marking station and no flies were recovered at a distance of five kilometers from a marking station. Fly longevity is relatively short, with an average on liver of 5.4 days and 6.1 days on sheep, although a very small percentage of flies were found on both liver and sheep for up to 35 days.

Habitat and climate influence the time of day when visitations occur. In the wet tropical forest, visitations increase up to midday, when they are highest, whereas in the dry tropical forest visitations are highest during the early part of the day, with another peak late in the day. The dip after midday becomes less pronounced as the rainy season progresses, and at its height the visitation pattern is very similar to that in the wet tropical forest. The factor affecting behavior is response to temperature, since the screwworm adult is seldom found below 22°C.

Another factor affecting behavior is the state of the ovaries. Flies collected on sheep are primarily gravid females, with 73% of the sheep-collected flies having mature eggs, compared with the liver-collected flies which are younger, with a smaller percentage of flies having oviposited at least once. Some of the flies had mixed egg masses, that is, the ovaries contained both mature eggs and other stages, which is important because it indicates that flies do not deposit all their eggs in one location, with 6% of the sheep-collected flies withholding some of their mature eggs. The ovarian state of the fly affects the daily behavior of individuals, which are almost isomers of one another. The sheep-collected flies have their peak activity in the afternoon, whereas those taken on liver have their peak activity in the morning, again gravid flies versus non-gravid.

The number of times the flies have oviposited is very similar during the two seasons for sheep-collected flies. Another finding was that only 2% of the flies collected on liver oviposited on the test sheep, which indicates a high level of ovipositing on wild animal hosts. Thus, when sheep have been used in the past, a large portion of the screwworm population has been overlooked because the flies do not respond to the sentinel sheep.

Summarizing the findings to date for the population structure, in the wet tropical forest there was no real pattern of variations during the months of the year, with differences in density occurring when there were lengthy periods of rain which kept the females from getting out to oviposit. However, for the dry tropical forest, there is a fairly predictable pattern of the population rising and falling. From March to June is a period of very low fly density, which is when the program could be most effective in releasing sterile adults.

Another study being made is on the content of the fly's gut to see the range of hosts on which it is feeding. The preliminary results indicate that 95% of the flies captured have fed on non-cattle hosts, with only 5% positive for bovines. Therefore, in that area infestations in wooded areas appear to result primarily from wild animals.

A question was asked about the age at first visitation to either liver or sheep, the answer being that for flies found on liver it was when they were about two to three days old, but on sheep it was usually when they were mature flies, about six days old. Another question was whether there was any indication from these studies as to how wide a barrier zone in Panama would have to be in order to be effective. Dr. Parker replied that the studies were done in small wooded areas, so it was difficult to generalize, but that once a female found a host, she would remain in that same area, returning to the same host many times. He also said that there are insufficient data available as yet on wet tropical forests to compare population densities between those areas and dry tropical forests.

Another question asked was about the ovarian development of flies collected on liver in comparison with those from animal wounds. The reply was that the flies found on liver do not oviposit. They feed there but oviposit elsewhere, as shown by the fact that 73% of the flies on sheep are gravid but only 1% of those on liver. Methods Development explained that consideration is being given to using powdered liver in the colony diet to advance ovarian development, and it would seem that it could be used to enhance the adult diet.

FIELD BEHAVIOR OF OW-87 PUPAE AND ADULTS WHEN CHILLED

Biotechnician Isaías Ochoa Cruz, from the methods development unit, reported on the field test which was a follow up to the laboratory test in this same area. Flies kept under chilled conditions for the same periods as in the laboratory were marked with six different colors to identify the treatment groups and then released from the center of a zone around which 12 traps were placed. The material collected was then taken to the laboratory to separate the colors for the periods of 72 and 96 hours, with 48 hours as controls. The results obtained for the pupal phase were the opposite from those found in the laboratory test. Similar tests had been done previously, in which different results were also obtained in the field and in the laboratory. These are preliminary data, as the test is still under way.

MODELLING SCREWORM POPULATION DYNAMICS

The next speaker was Dr. Dan Haile, from the ARS laboratory in Gainesville, Florida, who is acting as a consultant to the screwworm research group to advise on the development of a model of screwworm population dynamics. He explained that modelling can provide analytical tools that could help the screwworm project to become more efficient and cost effective and might help in establishing a barrier zone or combatting reinfestations in an eradicated area.

The Medical Veterinary Entomology Research Laboratory in Gainesville has been working with modelling for many years. Their approach connects biological and ecological data with different types of control -- chemical, physical, biological, or genetic -- and combines them into integrated management techniques. The type of model with which they are working is a deterministic, dynamic life table model, chosen because of its biological realism. Their models are all driven by weather and other environmental variables such as habitat and host density. They are run on a microcomputer, and work interactively. The models require a team effort, including engineers, entomologists, and computer programmers.

He described how the model run is begun by choosing a geographic area and feeding in the initial data such as the number of animals in the chosen area and number of parasites, with options for input data on the weather, vector, and parasite, and parameters such as the type of host, type of pasture, etc. He then presented a series of computer screens which progressively showed a simulation over time of the build-up of a parasite population and the effect of control treatments with acaricides and the sterile-insect technique. He explained that this was an example of the type of model they were trying to develop for screwworm population dynamics which would be useful for research and the operational program. Dr. Bram added that this model was now available on Dr. Whitten's computer, if anyone was interested in seeing it in more detail.

FUTURE PLANS OF ARS

Dr. Whitten said that many future plans had already been mentioned in the individual presentations, and that he would only add some comments about a few projects in Mexico

and Costa Rica. The orientation will be towards quantitative ecology, that is modelling, and determining the needs as the program moves southward. The working group for the modelling project will be made up of ~~Don Bailey~~, Bob Matlock, Frank Parker, John Welch, and others. These projects had been discussed at an ecology workshop held the previous week near San José, Costa Rica.

Bob Matlock

~~Don Bailey~~ will be working on determining the size of the barrier zone that would be needed. John Welch, who will be returning to the U. S., will evaluate the state of remote sensing and whether this technique would be applicable to the screwworm program. More emphasis will be placed on host-screwworm interaction. Rearing research will continue as the program expresses its needs, and when needed, the next strain will be developed.

FUTURE PLANS FOR METHODS DEVELOPMENT

Dr. Tom Ashley described the areas in which Methods Development will be involved during the coming year. First was the concern to find alternate gelling agents as a substitute for Water Lock, a very expensive ingredient which represents about two-thirds of the total cost of the diet. Grain Processing has sent them three gelling agents that have already been tested, with two more to be tested from that source. Other possibilities are soil conditioners used to grow plants, which cost 50% less than Water Lock and might prove to be effective replacements. Another gelling agent to be tested is being received from a company known as Polysorb.

Pre-mixed diets and formulated diets are another area. The former are pre-mixes of the current dietary ingredients. Two corporations, Land-of-Lakes and American Protein Corporation, are interested in supplying the pre-mixes and are submitting samples for testing. The advantage of the pre-mix is the elimination of the dry mixing process, since only water needs to be added. In the formulated diets, the animal proteins have been replaced with some plant proteins, and the same two corporations will be sending samples of formulated diets for testing.

With regard to neomycin, it was already reported that the lower limit has been established, as well as a concentration of neomycin that can be recommended if there is no detrimental behavior in the adults. Studies will include increasing the concentration to see if the upper limit can be defined.

Work will continue on naked pupation, which is close to becoming a reality, with some modifications in temperature and humidity.

This year they had tried unsuccessfully to eliminate meat from the adult diet, and these studies will continue. Samples of various dehydrated animal parts, including liver, will be tested, and it may be that the odor associated with these animal parts will serve as an ovarian stimulant for oogenesis in females, allowing meat, which is hard to handle and requires refrigeration, to be totally eliminated from the program.

Quality control is to be emphasized, particularly standardizing quality control tests between here and the various areas that do quality control outside the plant. A quality control manual will be prepared in both languages, with detailed procedures, diagrams, and equipment lists.

At the end of July the new strain will be received, and Methods will be involved in developing it to sufficient numbers for field release and in the field evaluation of this strain.

The last item would be the next major dietary enhancement. They had gone from meat, in different stages, to hydroponics and then to Water Lock, which had now been in use for a little over a year. However, Water Lock should not be considered the ultimate way to rear screwworm larvae and any ideas as to new possibilities would be welcome, as the goal is always to rear a better insect at less cost.

CLOSE OF THE MEETING

Dr. Bram said that the information provided by Drs. Whitten and Ashley gave them a very clear idea of where they were going and where they could complement each other in their research and methods development activities. He then asked Dr. Floyd Horn, ARS Director for the Southern Plains Area and a program Commissioner, to make some closing remarks.

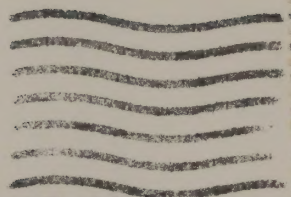
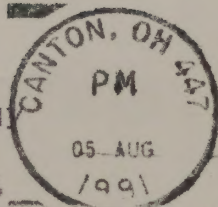
Dr. Horn commended the speakers for their presentations, and the leadership in the plant, operations, and ARS for cultivating this type of work, particularly by young people.

He said that implementation of rearing with the gel diet had obviously been highly successful. It was possible that economies could still be achieved with regard to some of the ingredients, but it appeared that it would be difficult to improve on the quality of the insects reared on the gelled diet. Special credit and attention should be given to the work done on dietary substitution both by the research and methods development people. It was good to see that environmental issues were being addressed, including the great improvement in the plant environment since hydroponics was no longer used, with other improvements being developed such as the elimination of formaldehyde that apparently could be implemented soon. It was also good that research on attractants is continuing in England, with encouraging results.

He felt that more thought should now be given to the future barrier zone and the control and surveillance programs that will be needed when that goal is reached, to learn what is different in that environment and what will be needed in order to have effective protection of the eradicated zones.

Drs. Wyss and Irastorza congratulated Dr. Ashley and Mr. Courtois for their organization of the meeting and thanked the participants for their attendance. Dr. Bram joined them in commending the speakers for their presentations and adjourned the meeting.

Ronald B. Hammond
1991 Program Chairman
Department of Entomology
OARDC-OSU
Wooster, OH 44691-4096



CANTON, OHIO 447 08/05/91 PM

C.J. Whitten
USDA-ARS
P.O. Box 3149
Laredo, TX ~~78040~~

0171

ESA National Conference
COMMUNICATION 1991

08/02/91
0171

Your presentation for the ESA National Conference in Reno has been scheduled as follows:

Category: 10-minute paper
Section: D
Day: Wednesday
Date: December 11, 1991
Time: 2:30 PM
Paper #: 1604

The program manuscript has gone to press. The only changes that can be made in the galley proof are cancellations. Please notify me at (216) 263-3727 if this presentation is to be cancelled.

Ronald B. Hammond, 1991 Program Chairman

RESEARCH PROGRESS

May 1990 - May 1991

C.J. Whitten

COLONIZATION GENETICS:

In cooperation with Frank Parker and John Welch, individual egg masses were reared in Costa Rica and pupae were transported to Tuxtla to be used for strain development. A new strain is projected to be ready for Methods Development at the end of July.

In conjunction with the development of the new strain in a conventional manner, a pre-strain strain has been developed from the same stocks as are being used to construct the regular strain. The pre-strain strain will be compared genetically to the regular strain after development. This comparison will suggest whether or not a strain could be assembled in a shorter time period than is currently used. This could be important in the event a special strain is needed on short notice.

The manuscripts on the genetics of asymmetrical mating behavior and ovarian development have been reviewed and will be finalized for submittal to the Journal of Heredity.

POPULATION MODELING

A workshop oriented to quantitative ecology was organized and completed. The results of the workshop will provide direction and formation of a team to develop a population dynamics model(s).

Data from field evaluations in which all raw data are available are being consolidated for statistical analyses. The objective is to present a predictive model that can be used to evaluate the results of a shortened (6 weeks of releases) strain evaluation.

The manuscript "Genetic Manipulation of Screwworm Populations" is in review stage.

AGENDA

ARS MEETING

May 14, 1991
8:30 am

CALL TO ORDER AND ANNOUNCEMENTS (Whitten)

INFORMATION FROM NPS AND AREA OFFICE

At 1:00 p.m., we will break for lunch and a special awards ceremony, otherwise no time schedule has been established.

RESEARCH RESULTS AND PLANS

Tuxtla-Gutierrez

Costa Rica

Fargo

Comments from visiting scientists

RESEARCH NEEDS

Personnel

Equipment - electrical inspection

SPECIAL PROJECTS

SPECIAL PRIORITIES

ACTION ITEMS - move from El Alto

MEETING SUMMARY (Bram and Horn) L Back up

10 May 1991

David B. Taylor
Research Entomologist

A. Research plans for 1991.

1. Genetic characterization of exceptional progeny of Y:Autosome translocations.

Progeny from crosses where the paternal parent is heterozygous for Y:Autosome or Y:Autosome:Autosome translocations include exceptional males. Exceptional males have phenotypes differing from those expected with pseudolinkage due to translocation mechanics. If these males are the result of physical recombination, they could cause degeneration of Y:Autosome based genetic sexing systems. Characterization of the genetic mechanisms responsible for the exceptional males and their genotypes is required so that stable genetic sexing strains can be constructed. Three genetic mechanisms have been postulated to give rise to exceptional males, meiotic recombination (absent in normal screwworm males), somatic recombination and survival of aneuploids. Each of these mechanisms results in a characteristic patterns of distribution of exceptional males among families, viabilities, and chromosomal complements.

Present status. Exceptional males occur at frequencies varying between 0 and 33% in the 14 Y:Autosome lines which have been examined. The frequency of exceptional males among families within lines is approximately equal and their viability appears to be reduced. These characteristics indicate that the exceptional males are surviving aneuploids. Two tests to confirm this are 1) cytological examination of the exceptional males and 2) crossing studies with the exceptional males. Cytological analysis of exceptional males from crosses involving males heterozygous for Y:Autosome:Autosome translocations indicate that the exceptional males retain both translocations. Aneuploids should have lost both translocations. Results of preliminary crosses are contrary to those expected under the aneuploid model as well. Mechanistic factors make meiotic and somatic recombination unlikely mechanisms for the generation of the exceptional males. Three recombinant events are needed to produce males of the phenotypes observed in the exceptional males. No individuals with phenotypes indicative of any 1 or 2 of those recombinant events alone have been observed. Results of these studies indicate that none of the 3 previously recognized mechanisms are responsible for the exceptional males observed in screwworm. This implies that a novel genetic mechanism, not previously described, must be producing the exceptional males observed in crosses involving Y:Autosome translocation heterozygotes in screwworm.

Plans for 1991. Preliminary crossing studies indicate that the exceptional males are semi-fertile. Crosses with these males indicate that no physical recombination has occurred and that their genotype is identical to that of their normal counterparts. In these crosses, only recessive morphological markers were used. Unfortunately, recessive markers do not allow me to identify all possible genotypes. I am presently constructing lines with electrophoretic markers. Because these are co-dominant markers, all genotypes can be characterized in crosses using them. Hopefully, upon the completion of these crosses, I will know the genetic nature of the exceptional males and their potential to contribute to the decomposition of genetic sexing strains. Because the mechanism appears to be novel, it will probably be beyond the scope of my work to do mechanistic studies.

2. Isozyme studies (in cooperation with Dr. Peterson).

Isozymes are variable forms of enzymes which can be used as genetic markers and to characterize intra- and inter-species population structures. Though several workers have done limited work with screwworm isozymes, no concerted effort has been made to develop and characterize enzyme systems in screwworm.

Present status. A polyacrylamide electrophoresis laboratory is currently operational. Approximately 25 enzyme systems have been screened with 2 buffer systems. About 20 of those systems appear to be scoreable.

Plans for 1991. We will continue to develop new enzyme systems and improve those that are already working. Laboratory colonies will be screened for variants at each of the enzyme systems. Variable lines will be selected to fixation and crosses will be performed to determine inheritance and genetic linkage of enzyme loci.

3. Genetic structure of screwworm populations. (in cooperation with Dr. Peterson)

Many statements concerning the genetic structure of screwworm populations have been made. However, no in depth and complete studies have been conducted to actually characterize screwworm populations. Such studies are needed for both practical and theoretical reasons. Practically, no base line data exist to which unusual screwworm populations can be compared. As populations are eradicated, such data become more difficult to acquire. In the event of a control failure, no data for "normal" populations, to which we can compare resisting population, exist. Determining if problem populations are reproductively isolated from the release strain and/or native populations which were controlled will be difficult. In addition, determining the relatedness of populations such as those in Libya to known populations or mass production strains and make predictions as to the compatibility of those populations to others of known origin is not possible without complicated and labor intensive crossing studies. Theoretically, the apparent population structure of screwworm is very unusual among insect. The level of variability is far smaller than that observed in any other insect species. It is important that we quantify this lack of variability and examine its influence on the success of the eradication program. In addition, the degree of relatedness of screwworm to other blowfly species and comparative population structure can be used to examine the possibilities of using other blowfly species as models for screwworm. Such model systems are needed due to the limitations of studying screwworm in eradicated zones and due to some of the peculiar physiological characteristics of screwworm such as autogeny which make many studies on screwworm difficult or impossible.

Plans for 1991. We would like to schedule a collecting trip to Costa Rica for late summer. The goal would be to collect 100 native screwworms from each of three sites in Costa Rica. *Cochliomyia macellaria* will be collected as well. These samples will be analyzed to determine levels of variability, population structure and genetic differentiation between *Cochliomyia hominivorax* and *Cochliomyia macellaria*. These data will be used as a base line for native screwworm populations in Central America.

B. Manuscripts.

1. Accepted in 1990.

Taylor, D.B. 1990. Genetics of interspecific hybridization in the *Triseriatus* and *Zoosophus* groups of the *Aedes* (*Protomacleaya*) (Diptera: Culicidae). *Ann. Entomol. Soc. Am.* 83: 1181-1191.

Taylor, D.B. 1991. Rearing systems for screwworm mass production. *In* T. E. Anderson & N.C. Leppa [Eds.], *Advances and Applications in Insect Rearing*. [In press].

Taylor, D.B., J.C. Bruce & R. Garcia. 1991. Gelled diet for Screwworm *Cochliomyia hominivorax* (Diptera: Calliphoridae) mass production. *J. Econ. Entomol.* [in press].

Taylor, D.B., L. Hammack & R.L. Roehrdanz. 1991. Reproductive compatibility of New World Screwworms, *Cochliomyia hominivorax*, from north Africa and Central America. *Medical & Veterinary Entomology* 5: 145-152.

2. In preparation or review.

Taylor, D.B. 1991. Strain Deterioration in the Screwworm Eradication Program, Nature vs Nurture. *Misc. Publ. ESA* [in review].

Taylor, D.B. 1992. Induced sex limited inheritance of autosomal characters in screwworm. *J. Heredity* (in prep.).

C. Presentations.

Reproductive compatibility of New World Screwworms from North Africa and Central America. Livestock Insect Workers Conference; Ithaca, NY; July 1990.

Genetic recombination in Y-autosome translocations of the screwworm. Entomological Society of America Annual Meeting, New Orleans, LA; December 1990.

Progress Report

May 14, 1991

F. D. Brewer, Research Entomologist

Tuxtla Gutiérrez, Chiapas, México

1. Gel Extenders in the Larval Diet of the Screwworm,
Cochliomyia hominivorax (Diptera: Calliphoridae).

F. D. Brewer.

STATUS:

Manuscript peer review completed and article submitted for publication to the J. of Econ. Entomol.

SUMMARY:

Larvae developed for 5 consecutive generations on 24 formulated meridic diets using different particle sizes of corn cob grit material as a partial or total replacement for a sodium polyacrylamide polyacrylate gelling agent. Sawdust was also tested with one size of the corn cob grits as a possible gel extender in the diet. There were no significant differences ($P = 0.05$) between insects reared on control diet and experimental diets in respect to fecundity, fertility, mean pupal weight, pupal yield, adult emergence and malformation.

Also ground pecan shell and peanut hull were added in a 8% final volume concentration to the larval diet to reduce the Water Lock gelling agent by 80%. There were significantly less pupae produced on both types of experimental diets containing the ground nutshells when compared to pupal yield from control diet without bulk material or diet containing corn cob grits to reduce the Water Lock. There were no significant differences for fecundity, fertility, mean pupal weight and percent pupal malformation among the control or these experimental diets.

IMPORTANCE:

The use of these bulk materials could represent considerable cost-savings in the diet by reduction or replacement of expensive gelling agent.

2. Alternate Pupation Medium for Larval Screwworms (Diptera: Calliphoridae).

STATUS:

The data has been collected and statistically analyzed. Manuscript has been prepared for peer review.

J. Medical Entomology.

SUMMARY:

Four particle sizes or grades of grit-o' cobs^R were found suitable as a pupation medium when compared to the sawdust control. No significant differences ($P = 0.05$) were observed among the treatments for the pupal and adult data except pupal weight was lower from larvae pupating on one of the cob grades. In a separate test evaluating particle size 2040 grit-o' cobs^R and sawdust in both the ARS and the Plant facilities no significant differences were observed among the pupal and adult parameters measured in these two separate environments.

IMPORTANCE:

Usage of the ground cob as a pupation medium for the larvae represents a suitable and acceptable source of material.

3. Feeding Regimes for Larval Screwworms (Diptera: Calliphoridae).

STATUS:

Data collection and analysis has been completed and a manuscript has been prepared for peer review.

J. Econ. Entomol.

SUMMARY:

The experimental feeding regimes from 3 separate tests were evaluated against a control of 500 ml of diet per day provided for 4 consecutive days (2000 ml total diet for 100 mg eggs [Ca. 2600 eggs]).

Pupal and adult parameters such as pupal yield, mean pupal weight, adult emergence by sex, fecundity, and fertility were analyzed for variance among the control and experimental groups. Five multiple and two of the one time only feeding regimes compared favorable with the control regime among the pupal and adult parameters measured.

IMPORTANCE:

Provide information on nutritional requirements of different aged larvae and establishing optimum feeding regimes for the larvae.

4. Gelled Meridic Diets for Adult Screwworm (Diptera: Calliphoridae).

STATUS: The data has been analyzed and a manuscript has been prepared for peer review. J. Entomological Science.

SUMMARY:

Flies fed meridic diets gelled with carrageenan along with those fed a control diet of honey and water were observed through time for weight by sex, mortality by sex, fecundity and fertility. The experimental diets were formulated with water, gel and sucrose plus either powdered whole (chicken) egg or powdered whole egg and powdered nonfat milk or powdered whole egg, powdered nonfat milk and dried bovine blood. Female flies laid significantly more eggs when fed the meridic diets than those fed on honey. The greatest fecundity was observed from females fed the sugar/egg/milk diet. Other dietary modifications were included in this study by which the carrageenan was replaced completely by a copolymer gel requiring no heating. No significant differences were observed among the parameters measured for this gel modification. A final test was conducted by which the carrageenan was successfully replaced by a combination of the copolymer gel and a bulk material or the none gel bulk material

alone.

IMPORTANCE:

The use of these gel meridic diets could have advantages such as cost-savings, ease of handling, logistics of ordering, storage, and desirability to work with compared to honey.

Summary of Projects Completed

STATUS:

Data has been collected from the following projects and statistically analyzed. The plans for the data are given for each project.

1. A gelling agent trademarked as Aridall 1125 (American Colloid Company) was formulated in both the larval and an adult diet in the same concentration as Water Lock in the control diets. Data was collected for 5 consecutive generations from the larval experiment and 6 consecutive generations from the adult experiment. Parameters measured in the larval diet study were pupal yield, mean pupal weight, malformed pupae, adult emergence by sex, malformed adults, adult mortality by sex, fecundity and fertility. The analyzed data is being considered as part of a manuscript by incorporating both studies which should provide further information about larval and adult gelled diets.
2. Larvae (Guatemala-88 strain) were reared on diet with and without powdered nonfat milk and weighed at 6 hour intervals commencing shortly following

egg hatch. Six different time interval measurements were taken in this study with a weighing of 250 larvae/interval. This study is earmarked for part of a manuscript and should be important in providing additional information on the nutrition of the early aged larvae.

3. Daily body weights were taken on larvae 2-7 days post-hatch, pupae 1-5 days in age and adults by sex, 1-7 days in age. This study is being planned as part of a manuscript and should be important for providing growth/development information for all phases of the life cycle in relationship to nutrition.
4. A peanut meal material was formulated in the larval diet at 7 different final volume concentrations of 0.52, 1.04, 1.55, 2.05, 2.55, 4.18 and 6.15% and compared to the control diet with no peanut meal. Larval, pupal and adult parameters were measured and recorded. This study is being planned as part of a manuscript pertaining to larval nutrition.
5. Five different final volume concentrations of a technical grade Casein (90% protein; 0.5% lactose)

were formulated in the larval diet in lieu of the powdered milk and evaluated along with the control diet containing milk. Weights were taken from 2-and 5-day old larvae and 5-day old pupae. Other data taken were pupal yield, percent adult emergence by sex, percent pupal and adult malformation, percent adult mortality by sex and fecundity. This information is being planned for publication and should be important in understanding more about larval nutrition.

6. Larvae were reared for 2 consecutive generations on diet with and without milk. Parameters measured were pupal yield, mean pupal weight, percent adult emergence by sex, fecundity, fertility and malformation in pupae and adults. This information is being planned for publication and should be important in understanding more about larval nutrition.

IMPORTANCE:

Provide information on dietary requirements of different aged larvae for optimum growth/development.

Summary of Projects Completed.

STATUS:

Data has been collected from the following project and is awaiting statistically analysis. The plans for the analyzed data are given below.

1. Larvae from the OW-87 strain were reared for 3 consecutive generations on a pre-formulated diet obtained commercially. Larval, pupal and adult parameters were measured against the standard larval gelled diet. Fecundity was recorded for 5 consecutive days from two different age groups of the adult feeding on a gelled meridic diet. The study is under consideration for publication to provide additional information about larval and adult nutrition during colonization.

Presentations

1. "Use of Inert Bulk Material for Screwworm (Calliphoridae: Cochliomyia hominivorax) Larval Diet and Pupation Medium." Annual Meeting, Entomological Society of America, December 1989, San Antonio, Texas.
2. "Use of Four Non-Nutritive Materials in the Larval Screwworm (Diptera: Calliphoridae) Diet as Extenders for the Gelling Agent." Second International Caribbean Conference of Entomology-Florida Entomological Society, August 1990, Cancun, México.
3. "Feeding Schedule Variations for Screwworm Larvae (Diptera: Calliphoridae)."
Second International Caribbean Conference of Entomology-Florida Entomological Society, August 1990, Cancun, México.
4. "Gelled Meridic Diets for Adult Screwworms."
Annual Meeting, Entomological Society of America, December 1990, New Orleans, Louisiana.

Summary of Current Research Proposals - 1991

F. D. Brewer

In cooperation with the Methods/Development and Production Sections of APHIS the following research areas will be emphasized. Each study will be conducted in ARS and/or under the Plant rearing conditions. The nutritional and rearing technology data representing all phases of the life cycle will be analyzed statistically for maximum interpretation. These findings will be used for decision making, recommendations and program planning in small-scale research efforts and large-scale or mass production for the eradication program.

- A. Development of dietary formulations to promote optimum growth/development for different aged larvae. Emphasis will initially be given to early-aged larvae since their nutritional requirements have been shown to be different from older larvae. The evaluation of different ingredients and feeding regimes of each formulation will be included in an existing experimental design. Data will be collected and analyzed statistically from all phases of the life cycle with particular attention given to the larval

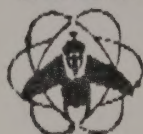
growth phase. The presently used larval meridic diet gelled with Water Lock G-400 will serve as the control diet. No timeframe for completion of the work can be given since relatively little is known in this area of research.

B. Evaluation of plant protein (soy) in both the larval and adult diet has been included in an experimental outline. This material (min. 50% protein) will be observed for its suitability as the major protein source in the diet or its usefulness as a mixture with other protein sources. This material will be incorporated in gelled meridic diets with the Water Lock G-400 serving as the gelling agent. The currently used gelled larval diet of blood/egg/milk substitute (6:3:3) and adult diet of sugar/egg/milk substitute (2:1:1) will serve as the control diets for the respective studies.

C. The evaluation of selected gelling agents, e.g. starch absorbent polymers, for solidifying both larval and adult established meridic diets has been included in an experimental design. These gels will be tested in the diets against similar

diets gelled with the synthetic polymer Water Lock G-400 as the control gel.

- D. Evaluation of different concentrations of spent larval media is being planned when used in combination with lean ground meat and/or substitute to maximize fecundity during the egg collection period.

**COMISION MEXICO-AMERICANA PARA LA ERRADICACION
DEL GUSANO BARRENADOR DEL GANADO**

FAX TEL 2-54-51-50
TEL 2-50-10-44
EXT. 108

FORMA PARA TRANSMITIR TELEFAX

PARA Dr. James Witten

FAX No. _____

COMPANIA Comisión

PAIS México

CIUDAD Tuxtla Gutiérrez (ARS)

DE Subdirectores Generales

FECHA Abril 10, 1991

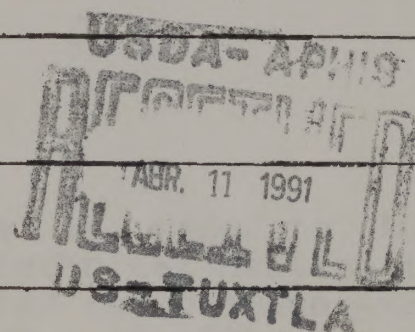
ASUNTO _____

NUMERO DE PAGINAS / (INCLUYENDO ESTA) 2

DESCRIPCION DEL DOCUMENTO _____

INSTRUCCIONES ESPECIALES _____

**FAVOR DE NOTIFICAR INMEDIATAMENTE EN CASO DE QUE NO HAYA
SIDO TRANSMITIDO RAPIDAMENTE.**





COMISION MEXICO-AMERICANA PARA LA ERRADICACION DEL GUSANO BARRENADOR
LA ENERGIA ATOMICA AL SERVICIO DEL GANADERO

SDG/CBC/113'91

ABRIL 9, 1991

APRIL 9, 1991

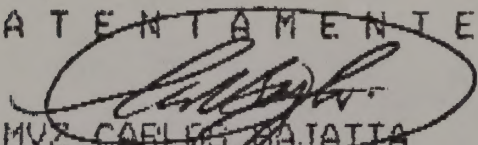
DR. JAMES WITTEN
JEFE DE ARS
PLANTA PRODUCTORA DE MOSCAS
ESTERILES
TUXTLA GUTIERREZ, CHIS.

En referencia a la Reunión Técnica y Anual llevada a cabo conjuntamente entre ARS y Comisión, por este conducto solicitamos a usted, que en caso de que ARS cuente ya con una propuesta de agenda, ésta sea enviada a los Subdirectores de Producción, con el propósito de elaborar en forma coordinada la agenda de la próxima reunión.

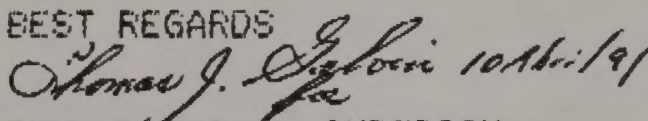
Reference is made to the Annual Technical Meeting to be carried out between ARS-Commission. If ARS has a proposal for the agenda, please send it to the Subdirectors of Production in order that they coordinate the subjects for the next meeting.

Agradeciendo de antemano las atenciones a la presente, quedamos de usted.

ATENTAMENTE


MVZ. CARLOS BAJAJITA
CARPIETTE
SUBDIRECTOR GENERAL

BEST REGARDS


DVM. DAVID W. ANDERSON
GENERAL SUBDIRECTOR

c.c.p. Directores Generales
Subdirectores de Producción
Subdirectores de Ops. de Campo
Entomólogos Asesores
Archivo

**REUNION ANUAL
"ANNUAL MEETING"**

**DEPTO. DE INVESTIGACION Y DESARROLLO EXP. Y A.R.S.
"DEPARTMENT OF METHODS DEVELOPMENT AND THE
AGRICULTURAL RESEARCH SERVICE"**

**PLANTA PRODUCTORA DE MOSCAS
"SCREWORM PRODUCTION FACILITY"**

**CHIAPA DE CORZO, CHIAPAS, MEXICO
15 DE MAYO DE 1991
"MAY 15, 1991"**

HORARIO / TIME	TEMARIO / TOPICS	PONIENTES / SPEAKERS
09:00	Apertura y Objetivos "Call to Order"	Dr. Bram M.V.Z. Irastorza Dr. Wyss
09:10	Bienvenida "Welcome"	M.V.Z. Hernández Dr. Hofmann
09:15	Estado Actual del Programa "Current Status of the Eradication Program"	D.V.M. Smith M.V.Z. Salazar
09:45	Introducción "Introduction"	I.B.Q. Courtois Dr. Ashley
09:55	Condición de la Cepa OW-87 "Status of OW-87"	Biol. López M.V.Z. Hernández Dr. Mackley
10:25	Desarrollo de la Cepa Costa Rica-91 "Development of the Strain Costa Rica-91"	Dr. Whitten
10:40	Fortificadores de Dieta Larvaria/A.A. "Larval Diet Fortifiers/ A.A."	Dr. Friese
10:55	Dietas Gelificadas para Adultos y Larvas "Gelled Meridic Adult and Larval Diets"	Dr. Brewer I.B.Q. Alvarez

11:15	Receso "Coffee Break"	
11:30	Neomicina en la Dieta Larvaria "Neomycin in the Larval Diet"	Ing. Villalobos I.B.Q. Jonapá Microb. Babilonia
11:50	Condición de Investigación con Atrayentes del Gusano Barrenador "Status of Screwworm Attractants Research"	Dr. Whitten
12:05	Diseño de Trampas y Colocación de Atrayentes para el Gusano Barrenador "Screwworm Trap Design and Attractant Deployment"	Dr. Torr Dr. Whitten
12:20	Persistencia de Moscas Estériles en Centros de Liberación. "Persistence of Sterile Flies at Release Sites"	Dr. Thomas
12:35	Desarrollo de Métodos en Guatemala "Methods Development in Guatemala"	M.V.Z. Calderón
12:50	Almuerzo "Lunch"	
13:35	Pupación al Desnudo "Naked Pupation"	Microb. Babilonia
13:50	Dosimetría "Dosimetry"	Ing. Cantú Microb. Babilonia
14:05	Pupa Refrigerada "Refrigerated Pupa"	Biol. Moctezuma Quim. Badillo
14:20	Respuesta de Pupa y Adulto al Enfriamiento OW-87 "Reaction of Pupae and Adults, OW-87, to Chilling"	Ing. Larrinaga
14:35	Envíos de Pupas a Distancias Largas "Long Distance Shipment of Pupae"	Dr. Whitten
14:50	La Mosca Aletargada en Belice "Chilled Fly Program in Belize"	P.H.D. Bailey M.V.Z. Martínez

*Natural
Re*

15:05	Receso "Coffee Break"	
15:20	Condición de Investigaciones Genéticas del Gusano Barrenador "Status of Screwworm Genetics Research"	Dr. Taylor
15:35	Ecología del Gusano Barrenador en Centro América "Screwworm Ecology In Central America"	Dr. Parker
15:50	Comportamiento en Campo de Pupa y Adulto, Sometidos al Frío, OW-87 "Field Behavior of Pupae and Adults When Chilled OW-87"	Biotéc. Ochoa
16:15	Modelos en Dinámica Poblacional del Gusano Barrenador "Modeling Screwworm Population Dinamics"	Dr. Haile
16:30	Planes Futuros de A.R.S. "Future Plans of A.R.S."	Dr. Whitten
16:45	Planes Futuros del D.I.D.E. "Future Plans for Methods"	I.B.Q. Courtois Dr. Ashley
17:00	Resumen y Conclusiones "Summary and Conclusions"	Dr. Bram M.V.Z. Irastorza D.V.M. Wyss



COMISION MEXICO-AMERICANA PARA LA ERRADICACION DEL GUSANO BARRENADOR
LA ENERGIA ATOMICA AL SERVICIO DEL GANADERO

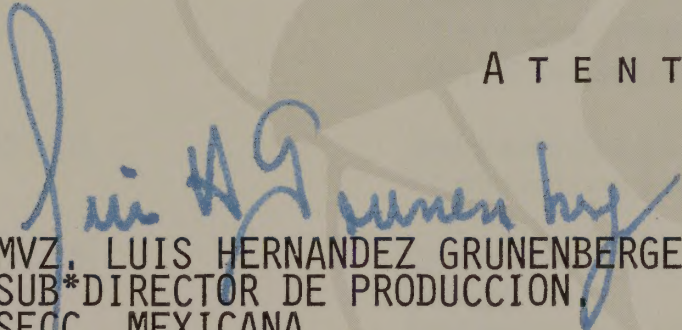
14 DE MAYO DE 1991.
REF.: SP-014-AC.

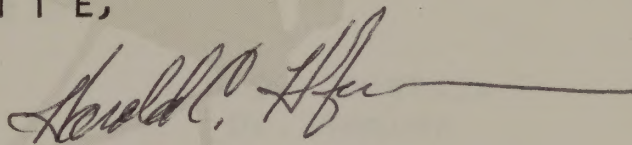
A: DR. C. JAMES WHITTEN,
JEFE DE INVESTIGACIONES,
AMERICAN RESEARCH SERVICE.
P L A N T A.

ADJUNTAMOS AGENDA DE TRABAJO PARA AGOTARSE EL DÍA 15 DE MAYO DE 1991, DEBIDAMENTE AUTORIZADA POR LOS SUB*DIRECTORES GENERALES DE LA COMISIÓN, CON EL FIN DE QUE HAGA DE SU CONOCIMIENTO A LOS INVESTIGADORES INVOLUCRADOS DE SU AGENCIA, Y LOGRAR EL MAYOR BENEFICIO EN EL EMPEÑO MUTUO, QUE ES EL DE ERRADICAR EN LA MANERA MÁS ÓPTIMA Y EFICAZ, AL GUSANO BARRENADOR DEL GANADO.

AGRADECEMOS ANTICIPADAMENTE SU COLABORACIÓN.

A T E N T A M E N T E,


MVZ. LUIS HERNANDEZ GRUNENBERGER,
SUB*DIRECTOR DE PRODUCCION,
SECC. MEXICANA.


DR. HAROLD C. HOFMANN,
SUB*DIRECTOR DE PRODUCCION,
SECC. AMERICANA.

C.C.P.- DIRECTORES GENERALES, OFNAS. CENTRALES.- MÉXICO, D.F.
C.C.P.- SUB*DIRECTORES GENERALES, OFNAS. CENTRALES.- MÉXICO, D.F.
C.C.P.- SUB*DIRECTORES ADMVOS., OFNAS. CENTRALES.- MÉXICO, D. F.
C.C.P.- ARCHIVO.
C.C.P.- CONSECUTIVO.

*ARA.

REUNION ANUAL
"ANNUAL MEETING"

DEPTO. DE INVESTIGACION Y DESARROLLO EXP. Y A.R.S.
"DEPARTMENT OF METHODS DEVELOPMENT AND THE
AGRICULTURAL RESEARCH SERVICE"

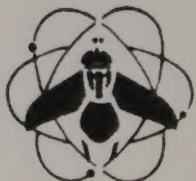
PLANTA PRODUCTORA DE MOSCAS
"SCREWORM PRODUCTION FACILITY"

CHIAPA DE CORZO, CHIAPAS, MEXICO
15 DE MAYO DE 1991
"MAY 15, 1991"

HORARIO / TIME	TEMARIO / TOPICS	PONIENTES / SPEAKERS
09:00	Apertura y Objetivos "Call to Order"	Dr. Bram M.V.Z. Irastorza Dr. Wyss
09:10	Bienvenida "Welcome"	M.V.Z. Hernández Dr. Hofmann
09:15	Estado Actual del Programa "Current Status of the Eradication Program"	D.V.M. Smith M.V.Z. Salazar
09:45	Introducción "Introduction"	I.B.Q. Courtois Dr. Ashley
09:55	Condición de la Cepa OW-87 "Status of OW-87"	Biol. López M.V.Z. Hernández Dr. Mackley
10:25	Desarrollo de la Cepa Costa Rica-91 "Development of the Strain Costa Rica-91"	Dr. Whitten
10:40	Fortificadores de Dieta Larvaria/A.A. "Larval Diet Fortifiers/ A.A."	Dr. Friese
10:55	Dietas Gelificadas para Adultos y Larvas "Gelled Meridic Adult and Larval Diets"	Dr. Brewer I.B.Q. Alvarez

11:15	Receso "Coffee Break"	
11:30	Neomicina en la Dieta Larvaria "Neomycin in the Larval Diet"	Ing. Villalobos I.B.Q. Jonapá Microb. Babilonia
11:50	Condición de Investigación con Atrayentes del Gusano Barrenador "Status of Screwworm Attractants Research"	Dr. Whitten
12:05	Diseño de Trampas y Colocación de Atrayentes para el Gusano Barrenador "Screwworm Trap Design and Attractant Deployment"	Dr. Torr Dr. Whitten
12:20	Persistencia de Moscas Estériles en Centros de Liberación. "Persistence of Sterile Flies at Release Sites"	Dr. Thomas
12:35	Desarrollo de Métodos en Guatemala "Methods Development in Guatemala"	M.V.Z. Calderón
12:50	Almuerzo "Lunch"	
13:35	Pupación al Desnudo "Naked Pupation"	Microb. Babilonia
13:50	Dosimetría "Dosimetry"	Ing. Cantú Microb. Babilonia
14:05	Pupa Refrigerada "Refrigerated Pupa"	Biol. Moctezuma Quim. Badillo
14:20	Respuesta de Pupa y Adulto al Enfriamiento OW-87 "Reaction of Pupae and Adults, OW-87, to Chilling"	Ing. Larrinaga
14:35	Envíos de Pupas a Distancias Largas "Long Distance Shipment of Pupae"	Dr. Whitten
14:50	La Mosca Aletargada en Belice "Chilled Fly Program in Belize"	P.H.D. Bailey M.V.Z. Martínez

15:05	Receso "Coffee Break"	
15:20	Condición de Investigaciones Genéticas del Gusano Barrenador "Status of Screwworm Genetics Research"	Dr. Taylor
15:35	Ecología del Gusano Barrenador en Centro América "Screwworm Ecology In Central America"	Dr. Parker
15:50	Comportamiento en Campo de Pupa y Adulto, Sometidos al Frío, OW-87 "Field Behavior of Pupae and Adults When Chilled OW-87"	Biotéc. Ochoa
16:15	Modelos en Dinámica Poblacional del Gusano Barrenador "Modeling Screwworm Population Dinamics"	Dr. Haile
16:30	Planes Futuros de A.R.S. "Future Plans of A.R.S."	Dr. Whitten
16:45	Planes Futuros del D.I.D.E. "Future Plans for Methods"	I.B.Q. Courtois Dr. Ashley
17:00	Resumen y Conclusiones "Summary and Conclusions"	Dr. Bram M.V.Z. Irastorza D.V.M. Wyss



COMISION MEXICO-AMERICANA PARA LA ERRADICACION DEL GUSANO BARRENADOR

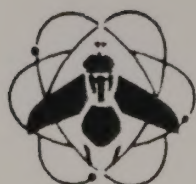
LA ENERGIA ATOMICA AL SERVICIO DEL GANADERO

JUNTA DE TRABAJO PARA LA ACTUALIZACION DE LA METODOLOGIA DE CONTROL DE CALIDAD

FECHA: MAYO 16 DE 1991.

Itinerario

HORA	LUGAR:	ACTIVIDADES
08:00 A.M.	Planta de Moscas	Observación del manejo de la pupa por enviarse a Ocozocoautla incluyendo la operación de Transporte
	GUIAS:	Ing. Victorino Hernández Sr. Ramiro Ramírez Ing. Raquel Courtois. Dr. Thomas Ashley
09:00 A.M.	Planta de Moscas	Traslado de todo el grupo al Centro de Distribución de Ocozocoautla.
09:45 A.M.	Centro de Ocozocoautla.	A) Recepción y observación de las maniobras, y pruebas de Control de Calidad al arribo de la pupa.
	GUIAS:	Sr. Eufracio Herrera Sr. Lizandro González
		B) Observación y Explicación de: - Control de Calidad de la dieta de adultos.. - Empacado en Cajas. - Almacén en Cámaras de Ambiente Controlado.



COMISION MEXICO-AMERICANA PARA LA ERRADICACION DEL GUSANO BARRENADOR

LA ENERGIA ATOMICA AL SERVICIO DEL GANADERO

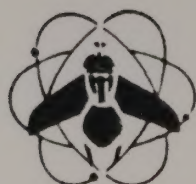
- Pruebas previas al envío a los Centros de Dispersión.
- Envío de Pupa-Mosca a Centros de Dispersión y condiciones ambientales durante el viaje.
- Procedimientos establecidos en la operación de Transporte Terrestre de la pupa-mosca.
- Procedimientos de Control de Calidad del Transporte.
- Pruebas rutinarias de Control de Calidad de Empaque, Almacén, Dispersión.
- Rangos de los parámetros de Calidad; Análisis para su uso práctico en Almacén, Transporte y Dispersión.

GUIAS: Sr. Eufrazio Herrera
Ing. Victorino Hernández.
Sr. Lizandro González.
M.V.Z. Oscar Correa
Ing. María Larrinaga

11:00 A.M. Centro de Ocozocoautla - Traslado a la Planta de todo el grupo.

11:45 A.M. Planta de Moscas A) Recorrido al Interior de la Planta explicándose las pruebas de Control de Calidad que efectúa Producción durante el proceso de desarrollo del producto.

GUIAS: M.V.Z. Luis Hernández
Dr. James Mackley



COMISION MEXICO-AMERICANA PARA LA ERRADICACION DEL GUSANO BARRENADOR

LA ENERGIA ATOMICA AL SERVICIO DEL GANADERO

B) Visita al área de Control de Calidad del D.I.D.E. explicándose las pruebas ahí efectuadas.

GUIA: Biól. Irene López.

13:15 P.M. Planta de Moscas

- En la Sala de Juntas, Mesa Redonda entre todos los participantes, con discusiones de los ajustes y/o actualización que habrá de efectuarse en la metodología de Control de Calidad (de Planta y Centros).

MODERADORES: M.V.Z. Sergio J. Martínez
P.h.D. Donald L. Bailey

15:00 P.M. Planta de Moscas

- Sala de Juntas: discusión para actualizar procedimientos de Supervisión de Control de Calidad en Transportación y Centros de Dispersión.

Ing. Victorino Hernández
Sr. Ramiro Ramírez
M.V.Z. Oscar Correa R.
M.V. Alfredo Calderón
M.V.Z. Sergio J. Martínez G.
P.h.D. Donald L. Bailey

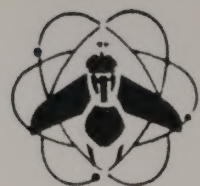
15:15 P.M. Planta de Moscas

- Sala de Juntas: establecimiento actual de vías de comunicación de la información de Control de Calidad.

M.V.Z. Concepción Silva M.

15:30 P.M. Planta de Moscas

- Término de la jornada del día.



COMISION MEXICO-AMERICANA PARA LA ERRADICACION DEL GUSANO BARRENADOR

LA ENERGIA ATOMICA AL SERVICIO DEL GANADERO

Participantes:

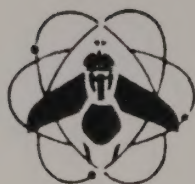
M.V.Z. Luis Hernández G.
Ing. Raquel Courtois
Biól. Irene López
Ing. Victorino Hernández.
M.V.Z. Oscar Correa
Ing. María Larrinaga
Sr. Eufrazio Herrera
M.V. Alfredo Calderón.
M.V. José M. Gutiérrez
M.V.Z. Concepción Silva M.
M.V.Z. Sergio J. Martínez G.

D.V.M. James Mackley
D.V.M. Tom Ashley

Sr. Ramiro Ramírez
Sr. Lizandro González

P.h.D. Donald L. Bailey

SMG/mejt*



COMISION MEXICO-AMERICANA PARA LA ERRADICACION DEL GUSANO BARRENADOR

LA ENERGIA ATOMICA AL SERVICIO DEL GANADERO

REUNION INFORMATIVA

DE LA JUNTA DE TRABAJO
PARA LA ACTUALIZACION DE LA
METODOLOGIA DE CONTROL DE CALIDAD

LUGAR: PLANTA PRODUCTORA DE MOSCAS ESTERILES
(Sala de Juntas)

FECHA: MAYO 17 DE 1991.

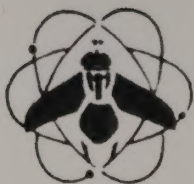
I. 09:30 Hrs. Palabras de Bienvenida MVZ. Luis Hernández C.
Dr. Harold Hofmann

II. 09:45 Hrs. Presentación MVZ. Carlos Bajatta C.
DVM. David W. Anderson
(Moderadores)

III. 10:00 Hrs. Control de Calidad en la Planta

1.- Introducción	Ing. Raquel Courtois
2.- Pesaje de Pupa	Dr. Thomas Ashley
3.- Tiempo y Período de de Emergencia	Biól. Irene López
4.- Proporción de sexos y Malformaciones	Biól. M.S. Gómez D.
5.- Resistencia a Inani- ción y Falta de Agua.	Nutriól. J. Marcos León
6.- Longevidad con Ali- mento y Agua.	Microb. Erick Babilonia
7.- Esterilidad	
8.- Agilidad de Vuelo.	

IV. 11:00 Hrs. Pesaje de Pupa MVZ. Luis Hernández G.
(Depto. de Producción) PhD. James Mackley



COMISION MEXICO-AMERICANA PARA LA ERRADICACION DEL GUSANO BARRENADOR

LA ENERGIA ATOMICA AL SERVICIO DEL GANADERO

V. 11:30 Hrs. Procedimientos de Transportación de pupa-mosca (Operación y Control de Calidad) Ing. Victorino Hernández
Sr. Ramiro Ramírez
Sr. Eufrazio Herrera
MVZ. Oscar Correa

VI. 12:00 Hrs. *Receso*

VII. 13:00 Hrs. Control de Calidad en Centros de Distribución y Dispersión.

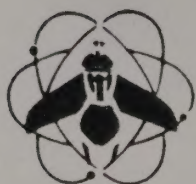
1.- Introducción	Sr. Lizandro González
2.- Tiempo y Período de Emergencia	Ing. María Larrinaga
3.- Resistencia a Inanición y Falta de Agua.	" " " "
4.- Longevidad con Alimento y Agua.	" " " "
5.- Agresividad sexual	Sr. Andrés Gallegos
6.- Agilidad de Vuelo (Laboratorio)	" " " "
7.- Agilidad de Vuelo (Dispersión)	MVZ. Oscar Correa MV. Alfredo Calderón

VIII. 14:00 Hrs. Rangos Establecidos de Calidad de la Mosca al Pre-Vuelo.

Emergencia	
Mortalidad	
Agilidad de Vuelo	
Edad de la Mosca	MVZ. Oscar Correa

IX. 14:30 Hrs. Supervisión de Control de Calidad en Centros de Dispersión. MVZ. Sergio Martínez
PhD. Donald Bailey

X. 14:40 Hrs. Comunicación de Informes de Control de Calidad MVZ. Concepción Silva



COMISION MEXICO-AMERICANA PARA LA ERRADICACION DEL GUSANO BARRENADOR
LA ENERGIA ATOMICA AL SERVICIO DEL GANADERO

XI. 14:50 Hrs. Conclusiones y
Recomendaciones.

MVZ. Carlos Bajatta C.
DVM. David W. Anderson

XII. 15:00 Hrs. Clausura

MVZ. Carlos Bajatta C.
DVM. David W. Anderson

SJM/mejx

Tom and Raquel

The following is a listing of topic titles and ARS presentor for the Annual ARS-Methods Planning Meeting for May 15.

Please insert each topic in the most appropriate place on the agenda.

Development of the Strain, Costa Rica-91	Whitten(ARS)
Larval Diet Fortifiers/Amino Acids	Friese(ARS)
Gelled Meridic Adult Diets	Brewer(ARS)
Status of Screwworm Genetics Research	Taylor(ARS)
Status of Screwworm Attractants Research	Whitten(ARS)
Screwworm Trap Design and Attractant Deployment	Torr(UK) Whitten(ARS)
Screwworm Ecology in Central America	Parker(ARS)
Persistence of Sterile Flies at Release Site	Thomas (ARS)
Long Distance Shipment of Screwworm Pupae	Mackley Whitten(ARS)
Modeling Screwworm Population Dynamics	Haile (ARS)



United States
Department of
Agriculture

Agricultural
Research
Service

National
Program
Staff

Beltsville, Maryland
20705

January 30, 1991

SUBJECT: Annual Screwworm Research and Methods Development Planning Meeting

TO: J. H. Wyss, APHIS-IS, Regional Director
Mexico City, Mexico

C. J. Whitten, RL
Screwworm Research Laboratory
Tuxtla Gutierrez, Mexico

D. R. Nelson, RL
Insect Biochemistry Research Unit
Fargo, ND

FROM: *R. A. Bram*
R. A. Bram, National Program Leader
Medical & Veterinary Entomology and Parasitology
E. Gersabeck
E. Gersabeck, APHIS-IS
Hyattsville, MD

In preparation for the annual Screwworm Research and Methods Development Planning Meeting scheduled to be held on May 22, 1991, at Tuxtla Gutierrez, Mexico, enclosed please find the tentative, jointly developed agenda. Please distribute, as appropriate, to individuals on your respective staffs who will be involved in this meeting with the request that they provide us with suggestions for modification and refinement of agenda topics. We would like to finalize the agenda by May 1, 1991.

As usual, we look forward to a most productive and stimulating exchange of scientific and technical information.

Enclosure

cc:

R. R. Oltjen, ARS

F. P. Horn, ARS

D. S. Campbell, APHIS-IS

Agricultural Attache, Mexico City

T E N T A T I V E A G E N D A

Screwworm Research and Methods Development Planning Meeting

Tuxtla Gutierrez, Chiapas, Mexico
May 22, 1991

9:00	Call to Order	Bram Irastorza Wyss
9:10	Welcome	Hernandez Hofmann
9:15	Current Status of Eradication Program	Smith
9:45	Status of Strain OW-87	Lopez
10:00	New Strain Development	Whitten Ashley
10:30	BREAK	
10:45	Development of Complete Larval Diet	Babilonia Brewer
11:15	Alternative Antimicrobial Agents in Larval Diet	Methods Development Whitten
11:45	Alternative Gelling Agents in Larval Diet	Methods Development
12:15	Larval Diet Fortifiers	Friese
12:30	LUNCH	
1:30	Alternative Pupation Media	Babilonia
1:50	Meat Extenders for Adult Diets <i>Billed meridic Adult Diet</i>	Methods Development Brewer
2:00	Status of Screwworm Genetics Research	Taylor
2:15	Status of Screwworm Attraction Research	Friese
2:30	BREAK	
2:45	Screwworm Ecology in Central America	Whitten Thomas Welch Parker
3:15	Screwworm Eradication in Libya	FAO/IAEA
3:40	Screwworm Production and Long Distance Shipment	Mackley Whitten
4:00	Modeling Screwworm Population Dynamics	Haile
4:15	Modeling Screwworm Production	Methods Development
4:30	ADJOURN	

MAY 15, 1991

BREWER, DOUG

ARS-METHODS MEETING

TOPIC: "GELLED MERIDIC DIETS FOR ADULTS"—10 MIN. PRESENTATION

INPUT:

AREAS

- 1) DEVELOPMENT OF COMPLETE LARVAL DIET.
- 2) ALTERNATIVE GELLING AGENTS IN LARVAL DIET
- 3) ALTERNATIVE PUPATION MEDIA

U. S. Department of Agriculture
Agricultural Research Service
SCREWORM RESEARCH LABORATORY MEMO

TO: All ARS Scientists

FROM: C.J. Whitten

DATE: March 25, 1991

SUBJECT: Agenda for Annual ARS-Methods Meeting, May 15, 1991

Attached is a very tentative agenda for the annual ARS-Methods Development meeting. You will find your name associated with a topic that was suggested by Bram and Gerzabeck as they constructed the agenda based upon last year's program. Please make corrections and/or provide me with the title of your proposed presentation and return to me.

Tom Ashley, Raquel, and I will consolidate our topics and times to prepare a suggested agenda to submit to Bram/Gerzabeck and the Commission.

I would appreciate your response by March 29.

Thanks.

COMMENTS/INSTRUCTIONS:

Please comment!
(before 1/29)

NUMBER OF PAGES (including cover page):

2

DATE:

January 24, 1991

DRAFT

U. S. Department of Agriculture
Agricultural Research Service
National Program Staff

FACSIMILE TRANSMISSION

Facsimile Number: FTS: 344-5467
COM: (301) 344-5467

FROM: Ralph A. Bram
National Program Leader
Medical & Veterinary Entomology
and Parasitology
BARC-West, Bldg. 005, Rm. 211
Beltsville, Maryland 20705
Phone: FTS: 344-2771
COM: (301) 344-2771

TO:

Jim Whitten

COMMENTS/INSTRUCTIONS:

Please comment!
(before 1/29)

NUMBER OF PAGES (including cover page):

2

DATE:

January 24, 1991

DRAFT

DAN

SCREWORM RESEARCH LABORATORY MEMO

TO: All ARS Scientists
FROM: C.J. Whitten
DATE: March 25, 1991
SUBJECT: Agenda for Annual ARS-Methods Meeting, May 15, 1991

=====

Attached is a very tentative agenda for the annual ARS-Methods Development meeting. You will find your name associated with a topic that was suggested by Bram and Gerzabeck as they constructed the agenda based upon last year's program. Please make corrections and/or provide me with the title of your proposed presentation and return to me.

Tom Ashley, Raquel, and I will consolidate our topics and times to prepare a suggested agenda to submit to Bram/Gerzabeck and the Commission.

I would appreciate your response by March 29.

Thanks.

T E N T A T I V E A G E N D A

Screwworm Research and Methods Development Planning Meeting

Tuxtla Gutierrez, Chiapas, Mexico
May 22, 1991

9:00	Call to Order	Bram Irastorza Wyss
9:10	Welcome	Hernandez Hofmann
9:15	Current Status of Eradication Program	Smith
9:45	Status of Strain OW-87	Lopez
10:00	New Strain Development	Whitten Ashley
10:30	BREAK	
10:45	Development of Complete Larval Diet	Babilonia Brewer
11:15	Alternative Antimicrobial Agents in Larval Diet	Methods Development Whitten
11:45	Alternative Gelling Agents in Larval Diet	Methods Development
12:15	Larval Diet Fortifiers - <i>Amino Acids</i>	Friese
12:30	LUNCH	
1:30	Alternative Pupation Media	Babilonia
1:50	Meat Extenders for Adult Diets	Methods Development
2:00	Status of Screwworm Genetics Research	Taylor
2:15	Status of Screwworm Attraction Research	Friese
2:30	BREAK	
2:45	Screwworm Ecology in Central America	Whitten Thomas Welch Parker
3:15	Screwworm Eradication in Libya	FAO/IAEA
3:40	Screwworm Production and Long Distance Shipment	Mackley Whitten
4:00	Modeling Screwworm Population Dynamics	Haile
4:15	Modeling Screwworm Production	Methods Development
4:30	ADJOURN	



COMISION MEXICO-AMERICANA PARA LA ERRADICACION DEL GUSANO BARRENADOR
LA ENERGIA ATOMICA AL SERVICIO DEL GANADERO

SDG/CBC/113'91

ABRIL 9, 1991

APRIL 9, 1991

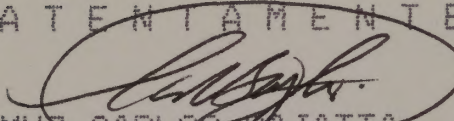
DR. JAMES WITTEN
JEFE DE ARS
PLANTA PRODUCTORA DE MOSCAS
ESTERILES
TUXTLA GUTIERREZ, CHIS.

En referencia a la Reunión Técnica y Anual llevada a cabo conjuntamente entre ARS y Comisión, por este conducto solicitamos a usted, que en caso de que ARS cuente ya con una propuesta de agenda, ésta sea enviada a los Subdirectores de Producción, con el propósito de elaborar en forma coordinada la agenda de la próxima reunión.

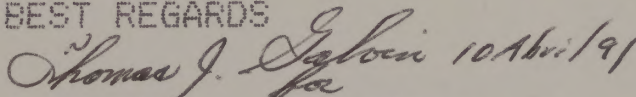
Reference is made to the Annual Technical Meeting to be carried out between ARS-Commission. If ARS has a proposal for the agenda, please send it to the Subdirectors of Production in order that they coordinate the subjects for the next meeting.

Agradeciendo de antemano las atenciones a la presente, quedamos de usted.

A T E N T A M E N T E


MVZ. CARLOS BAJATTA
CARPIETTE
SUBDIRECTOR GENERAL

BEST REGARDS


DVM. DAVID W. ANDERSON
GENERAL SUBDIRECTOR

c.c.p. Directores Generales
Subdirectores de Producción
Subdirectores de Ops. de Campo
Entomólogos Asesores
Archivo

